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एअर ब्रेक स्विचों की सम्मिश्र ईकाइयों और 650 वो ए सी से कम वोल्टता के लिए पुनः तार लगाये जाने वाले फ्यूज–विशिष्टि

(पहला पुनरीक्षण)

Indian Standard

COMPOSITE UNITS OF AIR-BREAK SWITCHES AND REWIRABLE TYPE FUSES FOR VOLTAGES NOT EXCEEDING 650 V a.c. — SPECIFICATION

(First Revision)

ICS 29.120.40; 29.120.50

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BUREAU OF INDIAN STANDARDS
MANAK BHAVAN, 9 BAHADUR SHAH ZAFAR MARG
NEW DELHI 110002

April 2000 **Price Group 10**

Low Voltage Switchgear and Controlgear Sectional Committee, ET 07

FOREWORD

This Indian Standard (First Revision) was adopted by the Bureau of Indian Standards, after the draft finalized by the Low Voltage Switchgear and Controlgear Sectional Committee had been approved by the Electrotechnical Division Council.

The majority of the switches being manufactured in India are metal-clad switches. Switches with insulated enclosures are also available in large quantities. These switches and fuse combination units, incorporating particularly rewirable type fuses are being manufactured in the small scale sector, intended for domestic and similar installations.

This standard has, therefore, been brought out primarily to meet the requirements of the manufacturer and the users in respect of rewirable type switch-fuse units for current ratings not exceeding 100 A and of duty categories AC-21A and AC-21B.

IS 13947 (Part 3) : 1993 'Specification for low-voltage switchgear and controlgear : Part 3 Switches, disconnectors and fuse combination units' has been published superseding IS 4064 (Part 1 and Part 2). It is, however, felt that while revising IS 10027 incorporating requirements contained in IS 13947 (Part 3), need for exclusively separate standard is maintained in view of composite units and rewirable type fuses manufactured in small scale sector intended for domestic and similar installations.

In the use of this standard, references shall have to be made to IS 2086 : 1993 'Specification for carriers and bases used in rewirable type electric fuses for voltage up to 650 V (*third revision*)'.

The object of this standard is to define:

a) The characteristics of the equipment;

b) The conditions with which the equipment shall comply with reference to:

    1) operation and behaviour in normal service;

    2) operation and behaviour in case of specified abnormal conditions, for example, short-circuit;

    3) dielectric properties;

c) The tests intended for confirming that these conditions have been met and the methods to be adopted for these tests; and

d) The data to be marked on the equipment.

For the purpose of deciding whether a particular requirement of this standard is complied with, the final value, observed or calculated, expressing the result of a test, shall be rounded off in accordance with IS 2 : 1960 'Rules for rounding off numerical values (*revised*)'. The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard.

Indian Standard
COMPOSITE UNITS OF AIR-BREAK SWITCHES AND REWIRABLE TYPE FUSES FOR VOLTAGES NOT EXCEEDING 650 V a.c. — SPECIFICATION
(First Revision)

1 SCOPE

1.1 This standard covers requirements for composite units of air-break switches and rewirable type electric fuses with rated current not exceeding 100 A intended for system voltages not exceeding 650 V a.c.

1.2 The switches incorporated in the composite units are intended for utilization category of AC-21A (frequent operational) and AC-21B (infrequent operation).

1.3 The rewirable type fuses, incorporated in composite units, shall conform to the requirements laid down in IS 2086

NOTE—It shall however be recognized that this imposes no restriction on rewirable type fuse-combination of other categories of duties or composite units incorporating cartridge type fuses in which case reference shall be made to IS 13947 (Part 3).

NOTE — This standard shall cover only composite units incorporating :

a) Air-break 'on' and 'off' switches of category AC-21A and AC-21B and for rated current not exceeding 100A,

b) Rewirable type of fuses only, and

c) Enclosure of metal-clad insulated types.

2 REFERENCES AND DEFINITIONS

2.0 The Indian Standards listed in Annex D are necessary adjuncts to this standard.

2.1 For the purpose of this standard, the following definitions in addition to those given in IS 1885 (Part 17) and IS 13947 (Part 1) shall apply.

2.2 Switch (Mechanical) — A mechanical switching device capable of making, carrying and breaking current under normal circuit conditions which may include specified operating overload conditions and also carrying for a specified time currents under specified abnormal circuit conditions such as those of short-circuit.

NOTE — A switch may be capable of making, but not breaking short-circuit currents.

2.3 Fuse-Combination Unit — A combination of a mechanical switching device and one or more fuses in a composite unit, assembled by the manufacturer or in accordance with his instructions.

2.4 Switch-Fuse — A switch in which one or more poles have a fuse in series in a composite unit.

2.5 Dependent Manual Operation (of a Mechanical Switching Device) — An operation solely by means of directly applied manual energy such that the speed and force of the operation are dependent upon the action of the operator.

2.6 Independent Manual Operation (of a Mechanical Switching Device) — A stored energy operator where the energy originates from manual power, stored and released in one continuous operation, such that the speed and force of the operation are independent of the action of the operator.

3 CHARACTERISTICS OF EQUIPMENT

3.1 Summary of Characteristics

The characteristics of the equipment shall be stated in terms of the following as applicable:

- Type of equipment (**3.2**)
- Rated quantities (*see* **3.3**)
- Utilization category (**3.3.7**)
- Dependent manual operation (*see* **2.5**)
- Independent manual operation (*see* **2.6**)
- Degree of protection (*see* Annex C)

3.2 Type of Equipment

The equipment shall have the following details:

a) *Number of Poles* — Either single pole with neutral, double pole or triple pole with neutral.

b) *Number of Positions* — The equipment shall have only two positions, that is 'on' and 'off'.

c) *Kind of Current* — The equipment shall be designed for use in single-phase or three-phase a.c. systems of rated frequency of 50 Hz.

3.3 Rated Quantities

Rated qualities are assigned as indicated in **3.3.1** and **3.3.2**, but it is not necessary to establish all the rated quantities listed.

3.3.1 *Rated Voltages*

An equipment is defined by the following rated voltages.

NOTE— Certain types of equipment may have more than one rated voltage or may have a rated voltage range.

3.3.1.1 *Rated operational voltage* (U_e)

A rated operational voltage of an equipment is a value of voltage which combined with a rated operational current, determines the application of the equipment and to which the relevant tests and the utilization categories are referred.

For single pole equipment, the rated operational voltage is generally stated as the voltage across the pole.

For multiple equipment, it is generally stated the voltage between phases.

NOTES

1 For certain devices and particular applications, a different method of stating U_e may apply; this should be stated in the relevant product standard;

2 For multiple equipment for use on polyphase circuits, a distinction may be made between:

a) Equipment for use in system where a single fault to earth will not cause the full phase to phase voltage to appear across a pole (that is unearthed and neutral earthed systems);

b) Equipment for use in system where a single fault to earth will cause to full to phase to phase voltage to appear across a pole (that is phase earthed systems);

c) An equipment may be assigned a number of combinations of rated operational voltages and rated operational currents or powers for different duties and utilization categories,

d) An equipment may be assigned a number of rated operational voltages and associated making and braking capacities for different duties and utilizations categories; and

e) Attention is drawn to the fact that the operational voltages may differ from the working voltages of an equipment.

3.3.1.2 *Rated insulation voltage* (U_i)

The rated insulation voltage of an equipment is the value of voltage to which dielectric tests voltage and creepage distances are referred.

In no case shall the maximum value of rated operational voltage exceed that of the rated insulation voltage.

NOTE — For equipment not having a specified rated insulation voltage, the highest value of the rated operational voltage is considered to be the rated insulation voltage.

3.3.1.3 *Rated impulse withstand voltage* (U_{imp})

The peak value of an impulse voltage of prescribed form and polarity which the equipment is capable of withstanding without failure under specified conditions of test and to which the value of the clearances are referred.

The rated impulse withstand voltage of an equipment shall be equal to or higher than the value stated for the transient over voltages occurring in the circuit in which the equipment is fitted.

3.3.2 *Currents*

An equipment is defined by the following currents.

3.3.2.1 *Conventional free air thermal current* (I_{th})

The conventional free air thermal current is the maximum value of test current to be used for temperature rise tests of unenclosed equipment in free air as given in Table 1.

The value of the conventional free air thermal current shall be at least equal to the maximum value of the rated operational current (*see* **3.3.2.3**) of the unenclosed equipment.

Free air is understood to be air under normal conditions reasonably free from draughts and external radiation.

NOTES

1 The current is not a rating and is not mandatorily marked on the equipment.

2 An unenclosed equipment is an equipment supplied by the manufacturer without an enclosure or an equipment supplied by the manufacturer with an integral enclosure which is not normally intended to be the sole equipment protective enclosure.

3.3.2.2 *Conventional enclosed thermal current* (I_{the})

The conventional enclosed thermal current is the value of current stated by the manufacturer to be used for the temperaturerise tests of the equipment when mounted in a specified enclosure. Such tests shall be in accordance with **5.3** and are mandatory if the equipment

Table 1 Temperature Rise Limits
(*Clauses* 3.3.2.1, 5.3,7.2.2, *and* 7.4.6)

Sl No. (1)	Type of Material and Description of Part (2)	Temperature Rise Limit (3)
i)	Contact parts (main and auxiliary contacts):	
	a) Copper: Uninterrupted duty	45 k
	b) Silver or silver-faced (*see* Note 1)	(*see* Note 2)
	c) All other metals or sintered metals	(*see* Note 3)
ii)	Bare conductors	(*see* Note 2)
iii)	Metallic parts acting as springs	(*see* Note 4)
iv)	Metallic parts in contact with insulating materials	(*see* Note 5)
v)	Terminals for external insulated connections	70 K (*see* Note 6)
vi)	Manual operating means (handles, levers, wheels, etc):	
	a) Parts of metal	15 K
	b) Parts of insulating material	25 K

NOTES

1 The expression 'silver-faced' includes solid silver inserts as well as electrolytically deposited silver, provided that, in the latter case, the temperature rise requirement of **7.4.6** are satisfied.

Contacts faced with other materials, the contact resistance of which is not significantly altered by oxidation, are treated as silver-faced contacts.

2 Limited solely by the necessity of not causing any damage to adjacent parts.

3 To be specified according to the properties of the metals used and limited by the necessity of not causing any damage to adjacent parts.

4 The resulting temperature shall not reach a value such that the elasticity of the material is impaired. For pure copper, this implies a total temperature not exceeding 75°C.

5 Limited solely by the necessity of not causing any damage to insulating materials.

6 The temperature rise limit of 70 K is a value based on the conventional test of **7.2.2**. An equipment used or tested under installation conditions may have connections the type, nature and disposition of which will not be the same as those adopted for the test; a different temperature rise of terminal may result and it may be rejected or accepted.

is described as enclosed equipment in the manufacturer's catalogues and normally intended for use with one or more enclosures of specified type and size (*see* Note 2).

The value of the conventional enclosed thermal current shall be at least equal to the maximum value of the rated operational current (*see* **3.3.2.3**) of the enclosed equipment.

If the equipment is normally intended for use in unspecified enclosures, the test is not mandatory if the test for conventional free air thermal current (I_{th}) has been made. In this case, the manufacturer shall be prepared to give guidance on the value of enclosed thermal current or the derating factor.

NOTES

1 This current is not a rating and is not mandatorily marked on the equipment.

2 The conventional enclosed thermal current value may be for unventilated equipment in which case the enclosure used for the test shall be of the size stated by the manufacturer as being the smallest that is applicable in service. Alternatively, the value may be for a ventilated equipment according to the manufacturer's data.

3 An enclosed equipment is an equipment normally intended for use with a specified type and size of enclosure or intended for use with more than one type of enclosure.

3.3.2.3 *Rated operational currents (I_C) or rated operational powers*

A rated operational current of an equipment is stated by the manufacturer and takes into account the rated operational voltage (*see* **3.3.1.1**), the rated frequency (*see* **3.3.3**), the rated duty, the utilization categories and the type of protective enclosure, if appropriate.

In the case of equipment for direct switching of individual motors, the indication of a rated operational current may be replaced or supplemented by an indication of the maximum rated power output, at the rated operational voltage considered, of the motor for which the equipment is intended. The manufacturer shall be prepared to state the relationship assumed between the operational current and the operational power, if any.

For the purpose of this standard, the preferred values of rated current shall be 16, 32, 63 and 100A.

3.3.2.4 *Rated uninterrupted current (I_u)*

The rated uninterrupted current of an equipment is a value of current, stated by the manufacturer, which the equipment can carry in uninterrupted duty.

3.3.3 *Rated Frequency*

The supply frequency for which an equipment is designed and to which the other characteristic values correspond.

For the purpose of this standard, the rated frequency shall be 50 Hz.

3.3.4 *Rated Making Capacity*

The rated making capacity of an equipment is a value of current, stated by the manufacturer, which the equipment can satisfactorily make under specified making conditions.

The making conditions which shall be specified are:

- the applied voltage
- the characteristics of the test circuit

The rated making capacity is stated by reference to be rated operational voltage and rated operational current, according to the relevant product standard.

NOTES

1 For a.c., rated making capacity is expressed by the r.m.s. value of the symmetrical component of the current, assumed to be constant.

2 For a.c. the peak value of the current during the first half-cycles following the closing of the main contacts of the equipment may be appreciably greater than the peak value of the current under steady state condition used in the determination of making capacity, depending on the power-factor of the circuit and the instant on the voltage wave when closing occurs.

3 An equipment should be capable of closing on a current having the a.c. component equal to that which defines its rated making capacity, whatever the value of the inherent d.c. component, within the limits resulting from the power-factors indicated in the Indian Standard.

The rated making capacity is stated by reference to the rated operational voltage and rated operational current and to the utilization category according to Table 2.

3.3.4.1 For a.c. the making current is expressed by the r.m.s. value of the periodic component of the current.

3.3.5 *Rated Breaking Capacity*

The rated breaking capacity of an equipment is a value of current, stated by the manufacturer, which the equipment can satisfactorily break, under specified breaking conditions.

The breaking conditions which shall be specified are:

- the characteristics of the test circuit
- the power frequency recovery voltage

The rated breaking capacity is stated by reference to the rated operational voltage and rated operational current.

An equipment shall be capable of breaking any value of current up to an including its rated breaking capacity.

NOTES

1 A switching device may have more than one rated breaking capacity, each corresponding to an operational voltage and a utilization category (AC -21 A or AC-21 B in this case).

Table 2 Verification of Rated Making and Breaking Capacities (*see* 7.4) Conditions for Making and Breaking Corresponding to the Various Utilization Categories

(*Clauses* 3.3.4, 3.3.7 *and* 7.4.4)

Utilization Category	Rated Operational Current	Make-Break			Number of Operating Cycles
		I_c/I_e	U_r/U_e	cos α	
AC-21A and AC-21B	All values	1.5	1.05	0.95	5

where

I = Making current

I_c = Breaking current

I_e = Rated operational current

U = Applied voltage

U_e = Rated operational voltage

U_r = Power frequency recovery voltage

2 For a.c. the rated breaking capacity is expressed by the rms value of symmetrical component of the current.

The rated breaking capacity is stated by reference to the rated operational voltage and rated voltage current and to the utilization categories according to Table 3 and **3.3.5**.

3.3.6 *Rated Fused Short-Circuit Current*

The rated fused short-circuit current of the equipment is the value of prospective current, stated by the manufacturer, which the equipment can satisfactorily withstand until the fuse blows.

The value of rated fused short-circuit current shall be as follows:

Rated Current (A)	*Fused Short-Circuit Current* (A) (r.m.s.)
16	2 000
32	4 000
63	4 000
100	4 000

The standard power factor shall be 0.8 and the ratio between the peak and the r.m.s. value of current shall be 1.47.

A power factor of 0.4 may be agreed to between the manufacturer and the user for special application, if necessary.

3.3.7 *Utilization Category*

The utilization categories define the intended applications and are given in Table 3.

Each utilization category is characterized by the values of the current and voltages, expressed as multiples of the rated operational current and the rated operational voltage, as well as the power-factor or time-constants of the circuit. The conditions for making and breaking given in Table 2. Correspond in principle to the applications listed in Table 3.

The designation of utilization categories is completed by the suffix A or B according to whether the intended applications require frequent or infrequent operations (*see* Table 3).

Utilization categories with suffix B are appropriate for devices which, due to design or application, are only intended for infrequent operation. This could apply, for example, to disconnectors normally only operated to provide isolation for maintenance work or switching devices where the fuselink blade forms the moving contact.

Table 3 Utilization Categories

(*Clauses* 3.3.5 *and* 3.3.7)

Nature of Current	**Frequent Operation**	**Infrequent Operation**	**Typical Applications**
Alternating current	AC-21A	AC-21B	Switching of resistive loads including moderate overloads

The utilization categories referred to in Table 2 and 3 do not apply to an equipment normally used to start, accelerate and/or stop individual motors. The utilization categories for such an equipment are dealt with in Annex A of IS 13947 (Part 3).

3.3.8 *Operational Performance*

Tests concerning the verification of the operational performance of an equipment are intended to verify that the equipment is capable of making and breaking without failure, the currents flowing in its main circuit for the intended use.

The number of operating cycles and the test circuit parameters for the operational performance test for the various utilization categories are given in Tables 4 and 4A.

The test conditions are specified in **7.6.1**.

3.3.9 *Durability*

NOTE — The term durability has been chosen instead of endurance in order to express the expectancy of the number of operating cycles which can be performed by the equipment before repair or replacement of parts. Moreover the term endurance is also commonly used to cover operational performance as defined in **3.3.8** and it was deemed necessary not to use the term endurance in this standard in order to avoid confusion between the two concepts.

3.3.9.1 *Mechanical durability*

With respect to its resistance to mechanical wear, an equipment is characterized by the number, stated in **7.7.1**, of this standard of no-load operating cycles (that is without current at the main contacts) which can be effected before it becomes necessary to service or replace any mechanical parts; however normal maintenance according to the manufacturer's instructions may be permitted for equipment designed to be maintained

Each operating cycle consists of one closing operation followed by one opening operation.

The equipment shall be mounted according to the manufacturer's instructions for the test.

3.3.9.2 *Electrical durability*

With respect to its resistance to electrical wear, an equipment is characterized by the number of on-load operating cycles corresponding to the service conditions given in **7.7.2** which can be made without repair or replacement.

NOTE — Preferred number of no-load and on-load operating cycles are given in Table 4.

4 STANDARD CONDITIONS FOR OPERATION IN SERVICE

4.1 *Normal Service Condition*

Equipment complying with this standard shall be capable of operating under the standard conditions given in **4.1.1** to **4.1.4**. For non-standard conditions in service *(see* Annex A).

Table 4 Verification of Operational Performance Number of Operating Cycles Corresponding to the Rated Operational Current

(*Clauses* 3.3.8, 3.3.9.2. *and* 7.6.1.1)

Rated Operational Current I_e	Number of Operating Cycles per Hour	Number of Operating Cycles					
		a.c. A Categories			a.c. B Categories		
		Without current	With current	Total	Without current	With current	Total
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
0 I_e 100	120	8 500	1 500	10 000	1 700	300	2 000

Table 4A Test Circuit Parameters for Table 4

Utilization Category	Rated Operational Current	Making (I)			Breaking		
		I_c/I_e	U_r/U_e	cos α	I_c/I_e	U_r/U_e	cos α
AC-21A and AC-21B	All values	1	1	0.95	1	1	0.95

where

I = Making current

I_c = Breaking current

I_e = Rated operational current

U = Voltage before make (applied voltage)

U_e = Rated operational voltage

U_r = Power frequency recovery voltage

For a.c. the making current is expressed by the r.m.s. value of the periodic component of the current.

4.1.1 *Ambient Air Temperature*

The ambient air temperature does not exceed 40°C and its average over a period of 24 h does not exceed + 35°C.

NOTE — Equipment intended to be used in ambient temperatures above + 40°C (for example, in forges, boiler rooms, tropical countries or below–5°C shall be designed or used according to an agreement between manufacturer and user. Information given in the manufacturer's catalogue may take the place of such an agreement.

4.1.2 *Altitude*

The altitude of the site of installation shall not exceed 2 000 m.

NOTE — For installations at higher altitudes, it is necessary to take into account the reduction of the dielectric strength and of the cooling effect of the air. Equipment so used shall be designed or used according to an agreement between manufacturer and user. Information given in the manufacturer's catalogue may take the place of such an agreement.

4.1.3 *Atmospheric Conditions*

The air is clean and its relative humidity does not exceed 50 percent at a maximum temperature of +40°C. Higher relative humidities may be permitted at lower temperature, for example, 90 percent at +20°C. Care shall be taken of moderate condensation which may occasionally occur due to variations in temperature.

4.1.4 *Condition of Installation*

The equipment is installed in accordance with the manufacturer's instructions.

5 STANDARD CONDITIONS FOR CONSTRUCTION

5.1 Mechanical Design

5.1.1 *General*

Materials shall be suitable for the particular application. The enclosed and the open positions of the equipment shall be definite and shall be clearly indicated either adjacent to the actuator or by the position of the latter. If symbols are used, 'I' and 'O' shall be used to indicate the closed and open positions respectively. The position indicator shall be connected to the moving contacts in a reliable way; the handle may form such an indicator, provided it cannot indicate the off position unless all the moving contacts are in the open position.

The operation shall be independent manual.

5.1.2 *Operating Handle*

The operating handle of the equipment shall be insulated from the live parts for the rated insulation voltage. Moreover:

a) if it is made of metal, it shall be capable of being satisfactorily connected to a protective conductor unless it is provided with additional reliable insulation; and

b) if it is made of or completely covered by insulating material, any internal metal parts, which might become accessible in the event of insulation damage, shall also be insulated from live parts for the rated insulation voltage or shall be capable of being satisfactorily connected to a protective conductor.

5.1.3 *Terminals*

5.1.3.1 *Constructional requirements*

All parts of terminals which maintain contact and carry current shall be of metal having adequate mechanical strength. The use of aluminium conductors as well as copper conductors shall be taken into account.

Terminal connections shall be such that the conductors may be connected by means of screws, springs or other equivalent means so as to ensure that the necessary contact pressure is maintained.

Terminals shall be so constructed that the conductors can be clamped between suitable surface without any significant damage either to conductors or terminals.

Terminals shall not allow the conductors to be displaced or be displaced themselves in a manner detrimental to the operation of equipment and the insulation voltage shall not be reduced below the rated values.

Examples of terminals are given in Annex B.

5.1.3.2 *Connecting capacity*

The manufacturer shall state the type (rigid solid or stranded or flexible), the minimum and the maximum cross-sections of conductors for which the terminal is suitable and, if applicable, the number of conductors simultaneously connectable to the terminal. However, the maximum cross-section shall not be smaller than that stated in **7.2** for the temperature rise test and the terminal shall be suitable for conductors of the same type (rigid solid or stranded or flexible) at least 2 sizes smaller, as given in the appropriate col of Table 5.

Terminals for connection to external conductors shall be readily accessible during installation.

Clamping screws and nuts shall not serve to fix any other component although they may hold the terminals in place or prevent them from turning.

Table 5 Standard Cross-Section of Aluminium and Copper Conductors Corrosponding to the Rated Currents

(*Clauses* 5.1.3.2 *and* 7.2.2)

Sl No.	Range of Test Current	Aluminium Conductor Size (mm²)	Copper Conductor Size (mm²)
(1)	(2)	(3)	(4)
i)	0-8	1.5	1.0
ii)	8-12	1.5	1.5
iii)	12-15	2.5	2.5
iv)	15-20	4.0	2.5
v)	20-25	6	4.0
vi)	25-32	10	6.0
vii)	32-50	16	10
viii)	50-65	25	16
ix)	65-85	35	25
x)	85-100	50	35

5.1.3.3 *Additional requirements for equipment provided with a neutral pole*

When an equipment is provided with a pole intended only for connecting the neutral, this pole shall be clearly identified to that effect by the letter 'N' (*see* **5.1.3.5**).

A switched neutral pole shall break not before and shall make not after the other poles.

For equipment having a value of conventional thermal current not exceeding 63 A, the value shall be identical for all poles.

For higher conventional thermal current values, the neutral pole may have a value of conventional thermal current different from that of the other poles, but not less than half that value or 63 A, whichever is the higher.

5.1.3.4 *Connections*

Terminals for connection to external conductors shall be readily accessible during installation. Clamping screws and nuts shall not serve to other component although they may hold the terminals in place or prevent them from turning.

5.1.3.5 *Terminals identification and marking*

Terminals shall be clearly and permanently identified in accordance with IS 11353.

Terminals intended exclusively for the neutral conductor shall be identified by the letter 'N'.

5.1.4 *Earthing*

5.1.4.1 The assembly comprising metallic chassis, framework and the fixed parts of the metal enclosures shall be provided with two separate earthing terminals. These terminals shall be proved over and above all other means provided for securing metallic enclosures (armour or other metallic covering) of current-carrying cables.

5.1.4.2 The earthing terminals shall be readily accessible and so placed that the earth connection is maintained when the cover of any other movable parts is removed.

5.1.4.3 The earthing terminals shall be of adequate size, be protected against corrosion and shall be metallically clean. Under no circumstances shall a movable metal part of the enclosure be insulated from the part carrying the earthing terminals when the movable part is in place.

5.1.4.4 The earthing terminals shall be identified by means of the symbol marked in a legible and indelible manner on or adjacent to the terminals.

5.2 Enclosures

The enclosure seal be so arranged that, when it is opened, the terminals as well as all parts requiring maintenance, as prescribed by the manufacturer, are readily accessible.

5.2.1 Sufficient space shall be left in the interior of the enclosure for the accommodation of external conductors from their point of entry into the enclosure as far as the terminal.

5.2.2 The movable parts of the protective enclosure shall be firmly secured to the fixed parts by a device such that they cannot be accidentally loosened or detached owing to the effects of operation of the equipment.

5.2.3 The enclosure of the unit shall be so designed as to allow the cover to open without the use of tools and the following requirements shall be fulfilled:

a) It shall not be possible to open the cover unless the switch is in the 'off' position.
b) With the cover of the enclosure open, means shall be provided so that:
   1) the fastening devices do not get lost;
   2) it is not possible to close the switch; and
   3) there is no possibility of accidental contact with the live parts.

5.2.4 *Degree of Protection*

Degree of protection as declared by the manufacturer shall be verified in accordance with Annex C.

5.3 Temperature Rise

The temperature rise of the several parts of an equipment, measured during the test carried out under the conditions specified in **7.2,** shall not exceed the values specified in Table 1. The temperature rise limits given therein are applicable only if the ambient air temperature remains within the limits given in **4.1.1**.

5.4 Dielectric Properties

The equipment shall be capable of withstanding the dielectric tests specified in **7.3**.

5.5 Operating Conditions

The equipment shall be operated in accordance with the manufacturer's instruction, if any, especially for equipments with dependent manual operation where the making and breaking capacities may depend on the skill of the operator.

6 PRODUCT INFORMATION

6.1 The following information shall be submitted by the manufacturer:

- Detailed drawing of the equipment indicating type and design of the equipment covering all parameters given at **5**.

6.2 Markings

The equipment shall be marked in a durable manner with the data given below:

a) Indication of the open and closed position. If symbols are used, they shall indicate the closed and open positions respectively as follows:

I ON (Power)
O Off (Power)

The following data shall also be marked on the equipment but need not be visible from the front when the equipment is mounted.

b) Manufacturer's name or trade-mark;
c) Type designation as per **6.1** and serial number;
d) Rated operational current (or rated power) at the rated operational voltage and utilization category (*see* **3.3.1, 3.3.2** and **3.3.4**);
e) Value (or range) of the rated frequency or the indication;
f) Rewirable fuse type and maximum rated current;
g) Ref to IS 10027 if certified by BIS;
h) Degree of protection of enclosed equipment;

The following terminals shall be identified:

j) line and load terminals;
k) neutral pole terminal, if applicable, by the lever 'N';

The following data shall be made available in the manufacturer's published information:

m) rated insulation voltage; and
n) rated fused short-circuit current.

6.3 BIS Certification Marking

The equipment may also be marked with Standard Mark.

6.3.1 The use of the Standard Mark is governed by the provisions of *Bureau of Indian Standards Act,* 1986 and the Rules and Regulations made thereunder. The details of conditions under which the licence for the use of Standard Mark may be granted to manufacturers or producers may be obtained from the Bureau of Indian Standards.

7 TESTS

7.0 Kinds of Tests

7.0.1 *General*

Tests shall be made to prove compliance with the requirements laid down in this standard.
Tests are as follows:

- Type tests which shall be made on representative samples of each particular equipment.
- Routine tests which shall be made on each

individual piece of equipment manufactured to this standard.

The above tests may consist of test sequence of required by purchaser or certifying authority.

The tests shall be carried out by the manufacturer, at his works or at any suitable laboratory directed by purchaser/ or certification authority.

7.0.2 *Type Tests*

Type tests are intended to verify compliance of the design of a given equipment with this standard.

They may comprise, as appropriate, the verification of:

- Constructional requirements (**5**),
- Temperature rise (**7.2**),
- Dielectric properties (7.3),
- Making and breaking capacities (**7.4**),
- Rated fused short-circuit current (**7.5**),
- Mechanical durability (**7.7.1**),
- Electrical durability (**7.7.2**),
- Operational performance (**7.6.1**), and
- Degree of protection of enclosed equipment (Annex C).

7.0.3 *Acceptance Test*

They comprise all tests at **7.0.2** except the following :

- Rated fused short-circuit current (**7.5**),
- Operational performance (**7.6.1**),
- Electrical durability (**7.7.2**), and
- Degree of protection of enclosed equipment (Annex C).

7.0.4 *Routine Tests* They comprise :

- Operation tests (**7.8.1**), and
- Dielectric test (**7.8.2**).

7.0.5 *Sampling Tests*

Sampling tests may also be made to verify specific properties or characteristics of an equipment, either on the manufacturer's own initiative, or by agreement between manufacturer and user. The tests may comprise:

a) Functional tests, and

b) Dielectric tests.

7.1 General Conditions of Test

7.1.1 The equipment to be tested shall agree in all its essential details with the drawings of the type which it represents. Unless otherwise specified, each type test shall be carried out on an equipment in a clean and new condition.

7.1.2 For the tests, the equipment shall be mounted and installed as indicated by the manufacturer. The details of the installation (type and size of enclosure if any, size of conductor, etc) shall be part of the test report.

Unless otherwise stated, the test shall be made with the same kind of current (and, in the case of a.c. the same frequency and with the same number of phases) as in the intended service.

If for convenience of testing, it appears desirable to increase the severity of a test (that is to adopt a higher rate of operation in order to reduce the duration of the test), this may be done only with the consent of the manufacturer.

NOTE — Equipment under test shall be mounted complete on its own support or an equivalent support and connected as in normal service, in accordance with the manufacturer's instructions and under the ambient conditions stated in **4.1.1**.

7.2 Verification of Temperature Rise Limits

7.2.1 *Ambient Air Temperature*

The ambient air temperature shall be measured during the last quarter of the test period by means of at least two thermometers or thermocouples equally distributed around the equipment at about half its height and at a distance of about 1 m from the equipment. The thermometers or thermocouples shall be protected against air currents heat radiation and indicating errors due to rapid temperature changes.

7.2.2 *Temperature Rise Tests of the Main Circuit*

The equipment shall be mounted approximately as under usual service conditions and shall be protected against undue external heating or cooling.

When temperature rise tests are made on an enclosed equipment, no openings giving false ventilation shall be allowed.

For equipment not supplied with an enclosure but intended to be used in an enclosure, the test for the rated current corresponding to an enclosed mounting shall be carried out in a chamber as stated by the manufacturer to be equivalent to the smallest enclosure that is applicable in service.

It is permissible, before beginning the tests, to operate the fuse-combination unit a few times with or without load.

The temperature rise is made at the rated current.

Tests shall be made at frequency between 45 and 62 Hz.

Fuse-combination units shall be fitted with fuse-wire having a rated current equal to the rated current of the combination unit.

The test shall be made over a period of time sufficient for the temperature rise to reach a steady-state value, but not exceeding 8 h. In practice, this condition is reached when the variation does not exceed 1°C/h .

NOTE — In practice, to shorten the test the current may be increased during the first part of the test; and may be reduced to the specified test current afterwords.

At the end of the test, the temperature rise of the different parts of the main circuit shall not exceed the values specified in Table 1.

The connections shall be single-core, PVC insulated, aluminium cables or copper cables with cross-sectional areas as given in Table 5.

In case of multipole equipment tested with a.c. the test shall be carried out with single-phase current, with all poles connected in series, but only as far as the errors resulting from magnetic influences can be neglected.

The connections shall be in free air and spaced not less than the distance existing between the terminals.

The minimum length of each temporary connection from terminal to terminal shall be:

a) 1 m for cross-sections up to and including 16 mm^2; and
b) 2 m for cross-sections larger than 16 mm^2.

7.2.3 *Measurement of the Temperature*

The temperature of the different parts shall be measured by means of the thermocouples at the nearest accessible position to the hottest spot.

Good heat conductivity between the thermocouple and the surface of the part under test shall be ensured. The thermocouple wire and junction shall be such that they do not influence the temperature rise of the part under test.

7.2.4 *Temperature Rise of a Part*

The temperature rise of a part is the difference between the temperature of this part measured in accordance with **7.2.3** and the ambient air temperature measured in accordance with **7.2.1**.

7.2.5 *Corrections*

If the ambient air temperature during the test is between +10°C, no correction is necessary to take account of the ambient temperature during the test and the values of Table 1 are the limiting values of temperature rise. If the ambient air temperature during the test exceed +40°C or is lower than +10°C, the manufacturer and the user shall make a special agreement.

7.3 Verification of Dielectric Properties

7.3.1 *Condition of the Equipment for Tests*

Dielectric tests shall be made on new equipment mounted approximately as under usual service conditions, including internal wiring, and in a dry condition.

When the base of equipment is of insulating material, metallic parts shall be placed at all the fixing points in accordance with the conditions of normal installation of the equipment and these parts shall be considered as part of the frame of the equipment. When the equipment is in an insulating enclosure, the latter shall be covered by a metal foil connected to the frame. If the operating handle is metallic, it shall be connected to the frame; if it is of insulating material, it shall be covered by a metal foil connected to frame.

Equipment not supplied with an enclosure but intended to be used in an enclosure shall be tested in an enclosure stated by the manufacturer to be equivalent to the smallest that is applicable in service.

When the dielectric strength of the equipment is dependent upon the taping or leads or the use of special insulation, such taping or special insulation shall also be used during the tests.

7.3.2 *Application of the Test Voltage*

The test voltage shall be applied for one minute as follows:

a) With the contacts closed:
   1) between all live parts of all poles connected together and the frame of the equipment; and
   2) between each pole and all the other poles connected to the frame of the equipment.

b) With the contacts open:
   1) between all live parts of all poles connected together, and the frame of the equipment; and
   2) between the terminals of one side connected together, and the terminals of the other side connected together.

For the purpose of the above tests, an insulated neutral is to be considered as a pole of the equipment.

7.3.3 *Value of the Test Voltage*

The test voltage shall have a sinusoidal waveform, and a frequency between 45 Hz and 62 Hz. The source of the test voltage shall be capable of supplying a short-circuit current of at least 0.5A.

Unless otherwise specified, the values of the test voltage shall be 2 000 V and 2 500 V respectively for 240 V and 415 V rated equipment.

7.4 Verification of Rated Making and Breaking Capacities

7.4.1 *Condition of the Apparatus for Tests*

The apparatus under test shall be mounted complete in its own enclosure and any apertures normally closed in service shall be closed for the test. For apparatus not supplied with an enclosure but intended to be used in an enclosure, the test shall be carried out in an enclosure stated by the manufacturer to be equivalent to the smallest that is applicable in service. The operating mechanism shall be operated in a manner similar to that stated by the manufacturer as being normal.

While carrying out the test, fuse-links shall be replaced by links of negligible impedance.

7.4.2 *Test Procedure*

The test circuit shall be as described in **7.4.3**. The mechanical switching device shall be closed and opened 5 times with an interval of approximately 30s between operations.

During each make-break operating cycle, the equipment need only stay in the closed position for a period long enough to allow the switching operation to be completed and to enable the current value to be established and the moving parts of the switching device to come to rest. After each operating cycle, the recovery voltage shall be maintained for at least 0.1s.

The test voltage and the load shall be applied to the appropriate terminals of the apparatus. For apparatus in which a moving contact remains connected to one of the terminals when the apparatus is in the open position, this test shall be repeated with the supply and load connections interchanged, unless the terminals are specifically and clearly, marked for load and supply.

7.4.3 *Test Circuit for the Verification of the Rated Making and Breaking Capacities*

Figures 1, 2 and 3 give the diagram of the circuits to be used for the tests.

The resistances R_1 and R_2 and the reactances L_1 and L_2 of the test circuit shall be adjusted to satisfy the specified test conditions. The resistors shall be air cored. They shall always be connected to the resistors and their values may be obtained by series coupling of individual reactors. Parallel connecting of reactors is permitted when these reactors have practically the same time constant.

The test circuit loads L_1 and R_1 shall be connected on the load side of the apparatus.

The prospective short-circuit current at the point of connection to the supply terminals of the apparatus shall be at least 10 times the value of the test current.

All parts of the apparatus normally earthed in service, including its enclosure, shall be insulated from earth and connected to a point as indicated in Fig. 1, 2 and 3. This connection shall include a reliable device D (such as a fuse consisting of a copper wire of 0.1 mm diameter and not less than 50 mm length) for the detection of the fault current and, if necessary, a resistor limiting the value of the prospective fault current to about 100 A. Any artificial neutral shall be substantially inductive, and permit a prospective fault current of at least 100 A. The test circuit shall be directly earthed at one point only and the position of this point shall be stated in the test report.

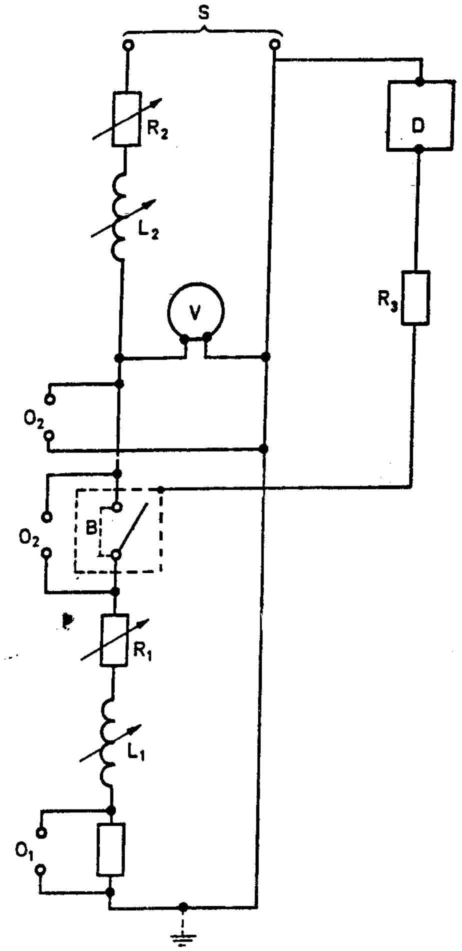
For tests corresponding to utilization category 'AC -21 A or AC -21 B' it is not necessary to adjust the oscillatory frequency of the prospective transient recovery voltage.

7.4.4 *Test Quantities*

The tests shall be performed with values stated by the manufacturer in accordance with Table 2.

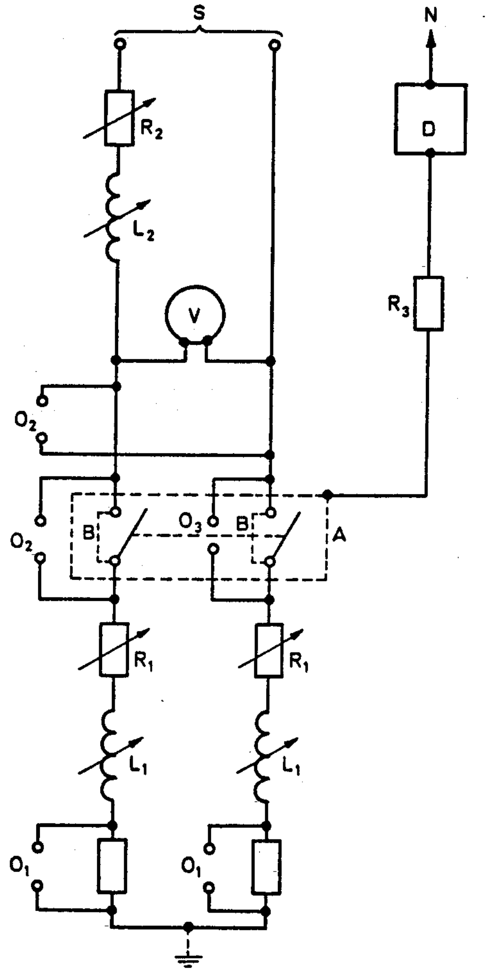
The tests shall be taken as valid if the values recorded in the test report differ from the values specified only within the following tolerances:

a)	Current	± 5 percent
b)	Voltage	± 5 percent
c)	Power-factor	± 0.05
d)	Time-constant	± 15 percent



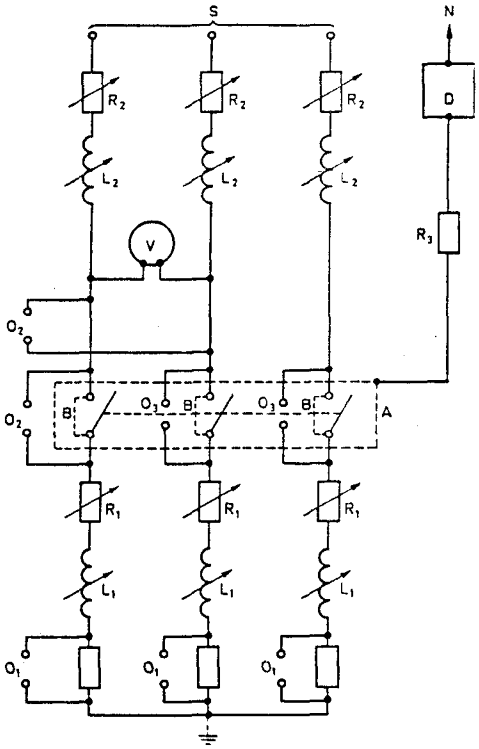
S	Supply
R_1, R_2	Adjustable resistors
L_1, L_2	Adjustable reactors
R_3	Resistor for limiting the current in device D
D	Device for detection of a fault current
A	Equipment under test
B	Temporary connection for prospective current calibration
O_1	To current recording oscilloscopes
O_2, O_3	To voltage recording osilloscopes
V	Voltmeter

FIG. 1 DIAGRAM OF THE TEST CIRCUIT FOR SINGLE-POLE EQUIPMENT ON SINGLE-PHASE a.c.



S	Supply
N	To the neutral point or mid-point of the d.c. supply
R_1, R_2	Adjustable resistors
L_1, L_2	Adjustable reactors
R_3	Resistor for limiting the current in device D
D	Device for detection of a fault current
A	Equipment under test
B	Temporary connection for prospective current calibration
O_1	To current recording oscilloscopes
O_2, O_3	To voltage recording osilloscopes
V	Voltmeter

FIG. 2 DIAGRAM OF THE TEST CIRCUIT FOR A TWO-POLE EQUIPMENT ON SINGLE-PHASE a.c.



S	Supply
N	To the neutral point
R_1, R_2	Adjustable resistors
L_1, L_2	Adjustable reactors
R_3	Resistor for limiting the current in device *D*
D	Device for detection of a fault current
A	Equipment under test
B	Temporary connection for prospective current calibration
O_1	To current recording oscilloscopes
O_2, O_3	To voltage recording osilloscopes
V	Voltmeter

FIG. 3 DIAGRAM OF THE TEST CIRCUIT FOR A THREE-POLE EQUIPMENT ON THREE-PHASE a.c.

The tests shall be made at the rated frequency of the apparatus as far as the testing station permits. If this frequency cannot be obtained, the test shall be made at a frequency between 45 and 62 Hz.

The power-factor shall be deemed to be the average of the cosines of the angles of phase displacement in all the phases, and the power-factor of any phase shall not vary from the average by more than 25 percent of that average.

7.4.5 *Behaviour of the Apparatus During the Making and Breaking Tests*

The apparatus shall perform during the above tests in such a manner as not to endanger an operator or cause damage to adjacent equipment. There shall be no permanent arcing nor flashover between poles or phases, and the fine wire fuse shall remain intact.

The apparatus shall remain mechanically operable and contact welding, such as to prevent an operation using normal operating means, is not permitted.

7.4.6 *Condition of the Apparatus after the Making and Breaking Tests*

After the tests made in accordance with **7.4.2**, the apparatus shall be capable, without maintenance, of withstanding a voltage equal to twice its rated insulation voltage, applied as stated in **7.3.2**.

It shall be demonstrated immediately after the test that the mechanical switching device will close and open satisfactorily during a no-load close-open operation.

NOTE — A closing operation is considered satisfactory when normal operation of the handle through its full stroke will close the contacts sufficiently for the mechanical switching device to be able to carry its rated current.

The contacts shall be in suitable condition to carry the rated current. Where doubt exists, a temperature rise test shall be carried out on the same apparatus; the measured temperature rise shall not exceed by more than 10°C the values given in Table 1 or result in damage to adjacent parts.

7.5 Verification of the Rated Fused Short-Circuit Current

7.5.1 *Condition of the Apparatus for the Test*

The apparatus shall be in the condition specified in **7.4.1** and the fuse-wire stated by the manufacturer shall be used.

7.5.2 A first test shall be made on the apparatus, with the mechanical switching device in the closed position, connected in series with a fuse-wire of the rated maximum current and rated breaking capacity deemed suitable by the manufacturer for use with that equipment. A prospective current corresponding to the rated fused short-circuit current of the apparatus shall be applied. The current value is the rms value determined from the prospective current oscillogram.

A second test shall be made with new fuse-wire and the test circuit made live with the mechanical switching device open. The mechanical switching device shall be closed onto a prospective current corresponding to the rated fused short-circuit current of the apparatus.

The recovery test shall be maintained for at least 0.1 second after interruption of the test current by the fuses.

Details of the fuse-wire used for the test shall be given in the test report. The type test with the specified fuse-wire shall be deemed to cover the use of any other fuse wire of rated current not exceeding that of the fuse-wire used for the test.

7.5.3 *Test Circuit*

The provisions of **7.4.3** shall apply.

The test circuit loads L_1 and R_1 are not included for the fused short-circuit current test.

7.5.4 *Test Quantities*

The test shall be made at the rated frequency of the apparatus as far as the testing station permits. If this frequency cannot be obtained, the tests shall be made at frequency between 45 and 62 Hz.

The average value of the power-frequency recovery voltage shall be equal to a value corresponding to not less than 110 percent and not more than 115 percent of the rated voltage stated by the manufacturer. The power-factor of the circuit shall be in accordance with **3.3.6**. The r.m.s. value of the a.c. component of the prospective current in any phase shall be equal to the specified value with a tolerance of $^{+15}_{-0}$ percent.

7.5.5 *Behaviour of the Apparatus During the Rated Fused Short-Circuit Current Test*

The apparatus shall behave as specified in **7.4.5**.

7.5.6 *Condition of the Apparatus after the Rated Fused Short-Circuit Current Test*

After the test, the apparatus shall comply with the requirements of **7.4.6**. The mechanical parts and the insulation of the apparatus shall be substantially in the same condition as before.

7.6 Verification of the Mechanical Endurance

7.6.1 *Operational Performance Test*

7.6.1.1 *Test values and conditions*

The test values are stated in Table 4 and 4A and **3.3.8** according to the utilization category.

The time interval between Table 4 operating cycles with current and without current and the sequential order of the tests shall be stated in the test report.

During each make-break operating cycle, the equipment need only stay in the closed position for a period long enough to allow switching operation to be completed and to enable the current value to be established and the moving parts of the equipment to come to rest. After each operating cycle, the recovery voltage shall be maintained for at least 0.05 s.

For a.c. the power-factor of the test circuit shall be determined in accordance with **7.4.4**. The values shall be in accordance with Table 4A and **3.3.8**.

7.6.1.2 Test Circuit (see 7.4)

7.6.1.3 *Transient recovery voltage*

It is not necessary to adjust the transient recovery voltage.

7.6.1.4 *Behaviour of the equipment during the operational performance test*

The equipment shall perform during the above tests in such a manner as not to endanger an operator or cause damage to adjacent equipment.

There shall be no permanent arcing or flash-over between poles or between poles and frame and no melting of the fuse in the detection circuit.

The equipment shall remain mechanically operable. Contact welding, such as to prevent an opening operation using normal operating means, is not permitted.

Some wear on the mechanism and contacts is allowed provided that the equipment functions correctly.

7.6.1.5 *Condition of the equipment after the operational performance test*

It shall be demonstrated immediately after the test that the equipment will close and open satisfactorily during a no-load close/open operation.

A closing operation is considered satisfactory when normal operation of the handle through its full stroke will close the contact efficiently for the equipment to be able to carry its rated operational current.

After the tests and without maintenance the equipment shall comply with the requirements of **7.3**.

The contacts shall be in a suitable condition to carry the rated operational current without maintenance and shall comply with the temperature-rise verification of **7.2**.

7.7 Durability (*see* 3.3.9)

7.7.1 *Mechanical Durability*

The mechanical durability test (*see* **3.3.9.1**) where required, is made in accordance with the appropriate requirements of **7.6.1** except that for equipment suitable for isolation, the maximum value of leakage cornet shall not exceed 6 mA per pole for all utilization categories.

The total number of operating cycles shall be as declared by the manufacturer.

If not stated by the manufacturer, the total number of operating cycles shall be taken from Table 4.

7.7.2 *Electrical Durability*

The electrical durability test (*see* **3.3.9.2**) where required, is made in accordance with the appropriate requirements of **7.6.1** except that for equipment suitable for the total number of operating cycles shall be as declared by the manufacturer.

If not stated by the manufacturer, total number of operating cycles shall be taken from Table 4.

7.8 Routine Tests

7.8.1 *Mechanical Operational Test*

A test shall be made to verify the correct mechanical operation of the equipment by five closing and opening operations.

7.8.2 *Dielectric Test*

The tests shall be carried out on dry and clean equipment.

The value of the test voltage shall be in accordance with **7.3.3**.

The duration of each test may be reduced to 1s.

The test voltage shall be applied as follows:

a) Between poles with the main contacts closed (with the contacts open if there is a shunt circuit between poles),
b) Between poles and the frame of the equipment with the main contacts closed, and
c) Across the terminals of each pole with the main contacts open.

The use of a metal foil, as specified in **7.3.1**, is necessary.

ANNEX A

(*Clause* 4.1)

INFORMATION TO BE GIVEN BY THE USER WHEN CONDITIONS FOR OPERATION IN SERVICE DIFFER FROM THE STANDARD

A-1 AMBIENT AIR TEMPERATURE

A-1.1 The user shall state to the manufacturer the expected range of ambient air temperature if this temperature is lower than – 5°C or higher than + 40°C.

A-2 ALTITUDE

A-2.1 The user shall state to the manufacturer the altitude of the place of installation if it is more than 2 000 m.

A-3 ATMOSPHERIC CONDITIONS

A-3.1 The user shall call the manufacturer's attention in case the atmosphere in which the equipment is to be installed may have a relative humidity greater than the values specified in **4.1.3** or contain an abnormal amount of dust, acids, corrosive gases, etc. The same applies if the equipment is to be installed near the sea.

A-4 CONDITIONS OF INSTALLATION

A-4.1 The user shall call the manufacturer's attention in case the equipment is to be fitted to a moving device, if its support is to be capable of assuming a sloping position either permanently or temporarily (equipment fitted aboard ships), or if it is to be exposed in service to abnormal shocks or vibrations.

A-5 CONNECTIONS WITH OTHER APPARATUS

A-5.1 The user shall inform the manufacturer of the type and dimensions of electrical connections with other apparatus in order to enable him to provide enclosures and terminals meeting the conditions of installation and temperature rise prescribed by this standard, and also to enable him to provide space, where necessary, to spread out conductors within the enclosure.

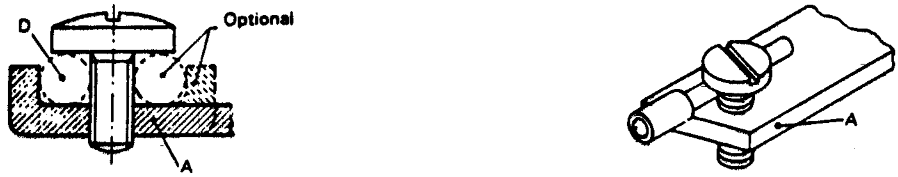
A-6 AUXILIARY CONTACTS

A-6.1 The user shall specify the number and type of auxiliary contacts to be supplied to satisfy requirements, such as signalling interlocking, etc.

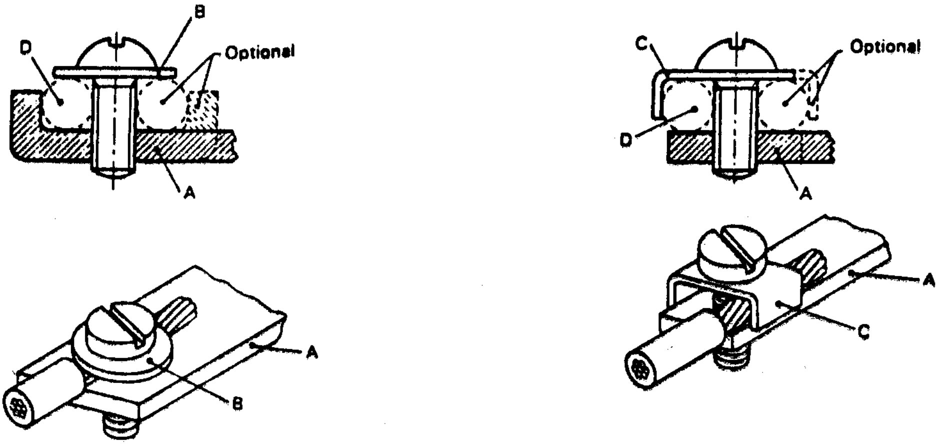
ANNEX B

(*Clause* 5.1.3.1)

EXAMPLES OF TERMINALS



Direct pressure through screw head



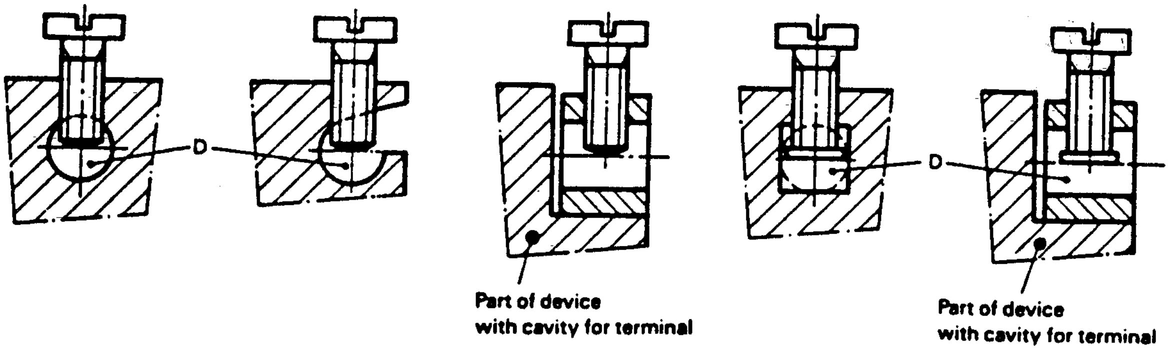
Indirect pressure through intermediate part

A — Fixed part
B — Washer or clamping plate
C — Anti-spread device
D — Conductor space

NOTE — Examples shown here do not prohibit the conductor being divided either side of the screw.

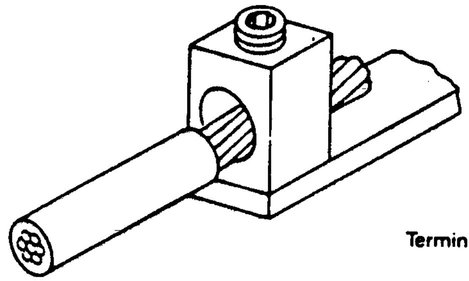
Screw terminal
Screw-type terminal in which the conductor is clamped under the head of one or more screws. The clamping pressure may by applied directly by the head of the screw or through an intermediate part, such as a washer, clamping plate or anti-spread device.

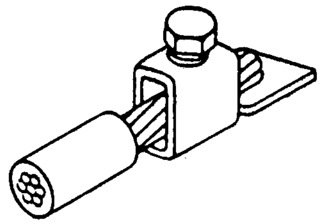
FIG. B1 SCREW TERMINALS


D
D
Part of device with cavity for terminal
Part of device with cavity for terminal

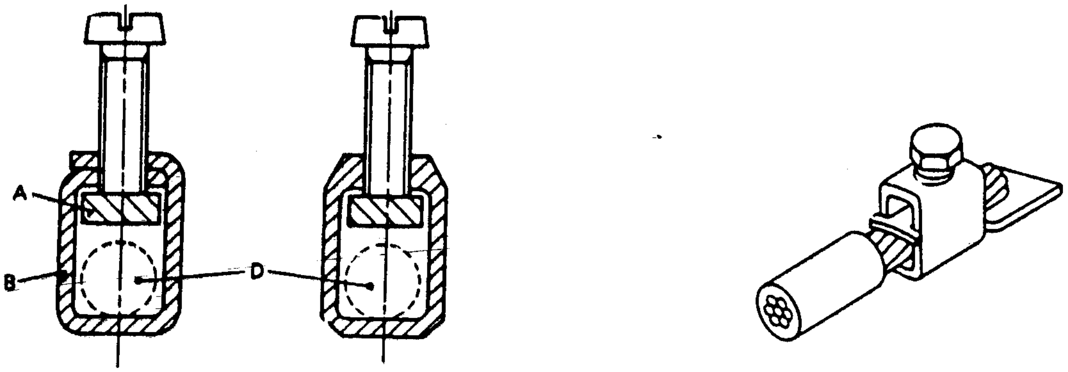
Terminals without pressure plate

Terminals with pressure plate





Terminals with direct pressure

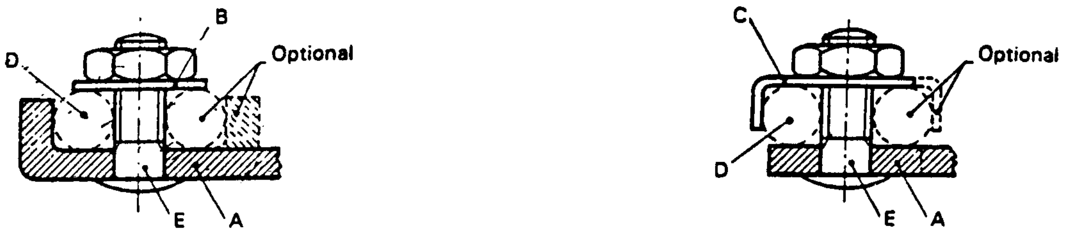


Terminals with indirect pressure

A — Fixed part
B — Body of the clamping unit
D — Conductor space

Pillar terminal
Screw-type terminal in which the conductor is inserted into a hole or cavity, where it is clamped under the shank of the screw or screws. The clamping pressure may be applied directly by the shank of the screw or through an intermediate part to which pressure is applied by the shank of the screw.

FIG. B2 PILLAR TERMINALS



A — Fixed part
B — Washer or clamping plate
C — Anti-spread device
D — Conductor space
E — Stud

NOTE —The part which retains the conductor in position may be of insulating material, provided the pressure necessary to clamp the conductor is not transmitted through the insulating material.

Stud terminal

Screw-type terminal in which the conductor is clamped under one or two unit. The clamping pressure may by applied directly by a suitably shaped nut or through an intermediate part, such as a washer, clamping plate or anti-spread device.

FIG. B3 STUD TERMINALS

ANNEX C

(*Clauses* 3.1, 5.2.4, 7.0.2 *and* 7.0.3)

DEGREE OF PROTECTION OF ENCLOSED EQUIPMENT

C-1 GENERAL

This annex provides information for specifying the degree of protection for enclosed equipment hereinafter referred to as equipment.

It also specifies type tests to check the degree of protection on the various types of enclosures of enclosed equipment.

All enclosed equipment is intended to provide protection as follows:

a) Protection of persons against contact with live parts and against contact with moving parts (other than smooth rotating shafts and the like) inside the enclosure, and

b) Protection of the equipment inside the enclosure against the ingress of solid foreign objects, and/or

c) Protection of the equipment inside the enclosure against harmful ingress of water.

This annex does not specify the protection of equipment against mechanical damage, risk of explosion or conditions such as moisture (produced by example, by condensation) corrosive vapours, fungus, or vermin. Internal barriers are considered for low-voltage switchgear and controlgear as part of the enclosure provided they meet at least the requirements of degree IP2X.

A part or the whole mounted equipment may constitute a part or the whole of a barrier.

The basic tests and conditions are given in IS 12063 but specific tests and interpretations apply to openings such as drain holes and ventilating openings, etc. All openings of enclosed equipment shall comply with the IP Code assigned to this equipment.

Drain holes are openings situated at the bottom of the enclosure and are intended to prevent the accumulation of water due to condensation and/or ingress of water into the enclosure. They shall comply with the basic requirements for openings and not be smaller than 2.5 mm in diameter.

C-2 DESIGNATION (CLASSIFICATION SYSTEM)

The designation to indicate the degree of protection consists of the characteristics letters IP followed by two numerals (the 'characteristic numerals') indicating conformity with the conditions stated in Tables C1 and C2 respectively. The first numeral indicates the degree of protection described under items a) and b) and the second numeral the degree of protection described under item c) of **C-1**.

Enclosures fitted with drain holes and/or ventilating openings shall satisfy the tests corresponding to their respective IP Code.

The degree of protection shall apply to all normal conditions of use.

Where the mounting of the equipment has an influence on the degree of protection, this shall be indicated by the manufacturer in his instructions for mounting or the like.

C-2.1 Single Characteristic Numeral

When it is required to indicate a class of protection by only one characteristic numeral, the omitted numeral shall be replaced by the letter X. For example IPX5 or IP2X.

C-2.2 Supplementary Letters

If required by the purchaser, supplier shall give additional information to be indicated by a suplementary letter or letters in the classification. In such cases, the product standard shall state clearly the additional conditions to be observed during tests for such a classification.

The supplementary letters are as follows:

W — (Placed immediately after the second characteristic numeral.) Equipment so designated is suitable for use under specific weather conditions and provision has been made for additional protective features or procedures.

Both the specified weather conditions and the additional features or procedures shall be agreed between manufacurer and user.

N — (Placed immediately after the second characteristic numeral.) Equipment so designated is suitable for use in environments where the particle size and the nature of the dust requires additional features to be added (for exmaple for use in sawmills and quarries).

Both the specified conditions and the additional features shall be agreed between manufacturer and user.

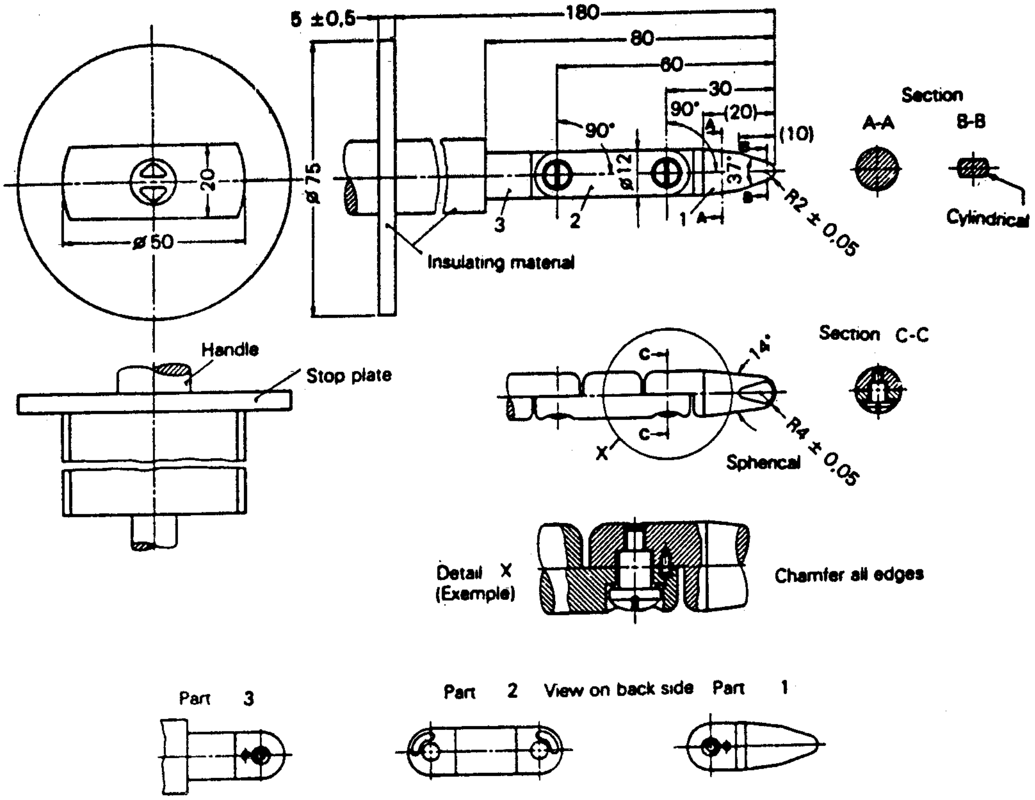
L — (Placed immediately after the first characteristic numeral 2, 3 or 4.) Equipment so identified has been tested to provide protection against ingress of solid objects exceeding 12.5 mm in diameter and against contact with live and moving parts by the standard test finger (*see* Fig. C1) in the case of first characteristic numeral 2, or a 2.5 mm diameter test probe in the case of characteristic numeral 3, or a 1 mm diameter test probe in the case of first characteristic numeral 4.

Table C1 Degrees of Protection Indicated by the First Characteristic Numeral

First Characteristic Numeral and Suffix	Short Description	Degree of Protection Definition (*see* C-3)	Test Conditions, Ref to
1	Protected against solid objects greater than 50 mm	Excludes solid objects exceeding 50 mm in dia and protects against contact with live and moving parts by a large body surface such as a hand (but not against deliberate access)	C-7.1
2L	Protected against solid objects greater than 12.5 mm and against contact by standard test finger	Excludes solid objects exceeding 12.5 mm in diameter and protects against contact with live and moving parts by a standard test finger or similar objects not exceeding 80 mm in length	C-7.2
3	Protected against solid objects greater than 2.5 mm	Excludes solid objects exceeding 12.5 mm in diameter or thickness	C -7.3.1

3L	Protected against solid objects greater than 12.5 mm and against contact by 2.5 mm probe	Excludes solid objects exceeding 12.5 mm in diameter and protects against contact with live and moving parts by a 2.5 mm diameter test probe not exceeding 100 mm in length	C- 7.3.2
4	Protected against solid objects greater than 1.0 mm	Excludes solid objects exceeding 1.0 mm in diameter or thickness	C-7.4.1
4L	Protects against solid objects greater than 12.5 mm and against contact by 1.0 mm probe	Excludes solid objects exceeding 12.5 mm in diameter and protects against contact with live and moving parts by a 1.0 mm diameter test probe not exceeding 100 mm in length	C-7.4.2

NOTE — The short description given in col 2 should not be used to specify the form of protection. It should only be used as a brief description.



Linear dimensions in millimetres

Tolerances on dimensions without specific tolerance:

0 0
- 10 on angles - 10'

on linear dimensions:

Up to 25 mm: $^{0}_{-0.05}$

over 25 mm: ±0.2

Material of finger: for example heat-treated steel

Both joints of this finger may be bent through an angle of $90^{+10°}_{0}$ but in one and the same direction only.

Using the pin and groove solution is only one of the possible approaches in order to limit the bending angle to 90°. For this reason dimensions and tolerances of these details are not given in the drawing. The actual design must ensure a 90° bending angle with a 0 to + 10° tolerance.

FIG. C1 STANDARD TEST FINGER

C-2.3 Example of Designation

IP 4 L 4

Characteristic letters

1st characteristic numeral
(*see* Table C1)

Supplementary letter

2nd characteristic numeral
(*see* Table C 2)

Equipment so designated provides protection against contacts with live and moving parts according to **C-2.2** supplementary letter L, against ingress of solid objects greater than 12.5 mm and against splashing water.

C-3 DEGREE OF PROTECTION — FIRST CHARACTERISITC NUMERAL

The first characteristic numeral indicates the degree of protection provided by the equipment both to the persons and to the equipment inside the enclosure.

Table C1 gives, in col 3, brief details of objects which will be excluded from the enclosure for each of the degrees of protection represented by the first characteristic numeral.

The term excluded implies that a part of the body or a tool or a wire held by a person, either will not enter the enclosure or, if it is permitted to enter, that adequate distance will be maintained between it and the live parts or dangerous moving parts (smooth rotating shafts and the like are not considered dangerous).

NOTE — The definition for adequate distance is given in C-6.1.

Column 3 of Table C1 also indicates the minimum size of solid foreign bodies which will be excluded.

NOTE — Equipment assigned a first characteristic numeral of 1 to 4 will exclude both regularly and irregularly shaped solid objects provided that three mutually perpendicular dimensions of the object exceed the appropriate value in col 3.

Compliance of enclosed equipment with a stated degree of protection implies that the enclosure will also comply with all lower degree of protection in Table C1. In consequence, the tests establishing these degrees of protection need not be carried out.

C-4 DEGREE OF PROTECTION — SECOND CHARACTERISTIC NUMERAL

The second characteristic numeral indicates the degree of protection of enclosed equipment with respect to harmful ingress of water.

Table C 2 gives, in col 3, details of the type of protection provided by the enclosure for each of the degree of protection represented by the second characteristic numeral.

Compliance of an enclosure with a stated degree of protection implies that the enclosure will also comply with all lower degrees of protection in Table C2. In consequence, the tests establishing these degrees of protection need not necessarily be carried out.

Table C 2 Degrees of Protection Indicated by the Second Characteristic Numeral

First Characteristic Numeral and Suffix	Degree of Protection		Test Conditions, Ref to
	Short Description	Definition (*see* C-3)	
1	Protected against dripping water	Dripping water (vertically falling drops) shall have no harmful effect	C-8.1
2	Protected against dripping water when tilted up to 15	Vertically dripping water shall have no harmful effect when the enclosure is tilted at any angle up to 15° from its normal position.	C-8.2
3	Protected against spraying water	Water falling as a spray at an angle up to 60° from the vertical shall have no harmful effect	C-8.3
4	Protected against splashing water	Water splashed against the enclosure from any direction shall have no harmful effect	C-8.4
5	Protected against water jets	Water projected by a nozzle against the enclosure from any direction shall have no harmful effect	Cr 8.5

NOTE — The short description given in col 2 should not be used to specify the form of protection. It should only be used as a brief description

C-5 MARKING

The requirements for marking are specified in the relevant product standard, where applicable.

C-6 GENERAL REQUIREMENTS FOR TESTS

The tests in this annex are type tests.

All tests shal be made with the equipment in an unenergized state.

The samples of equipment for each test shall be in a clean and new condition with all parts fitted and assembled as stated by the manufacturer for normal use.

Additional requirements, if any, my be given in the relevant product standard, concerning, for example

— number of samples; and
— mounting and installation of samples.

In the absence of such requirements, the manufacturer instruction shall apply.

The interpretation of test results is given in **C-7** and **C-8**.

C-6.1 Adequate Distance

For the purpose of the following test clauses in this annex, the term 'adequate distance' has the following meaning: the test device (sphere, finger, wire, etc) does not touch live parts or moving parts other than non-dangerous parts such as smooth rotating shafts.

C -7 TEST FOR FIRST CHARACTERISTIC NUMERAL

C-7.1 Test for First Numeral 1

The test is made with a rigid sphere of 50 mm in diameter applied against the opening(s) of the equipment with a force of 50 N ± 10 percent.

The protection is satisfactory if the sphere does not pass though any opening and adequate distance is maintained to parts which are normally live in service or moving parts inside the enclosure.

C-7.2 Test for First Numeral 2

The test comprises two parts a) and b) which shall be effected as follows:

a) *Finger Test*

The test is made with a metal test finger as shown in Fig. C1. Both joints of this finger may be bent through an angle of 90° with respect to the axis of the finger, but in one and the same direction only. The finger is pushed without undue force (not more than 10 N against any openings in the enclosure, and if it enters, it is placed in the most unfavourable position within the equipment.

The protection is satisfactory if adequate distance is maintained between the test finger and live or moving parts inside the enclosure.

For this mechanical test, the internal moving parts may be operated slowly, where this is possible.

A low-voltage supply (of not less than 40V) in series with a suitable lamp may be connected between the test finger and the live parts inside the enclosure. Conducting parts covered only with varnish or paint, or protected by oxidation or by a similar process, shall be covered with a metal foil electrically connected to those parts which are normally live in service.

The protection is satisfactory if the lamp does not light.

b) *Sphere Test*

The test is made with a rigid sphere of 12.5 mm in diameter applied to the openings of the enclosure with a force of 30 N ± 10 percent.

The protection is satisfactory if the sphere does not pass through any opening and adequate distance is maintained to live or moving parts inside the enclosure.

C-7.3 Test for First Numeral 3

C-7.3.1 *Protection Against Ingress of Solid Foreign Objects*

The test is made with a straight rigid steel wire or rod of 2.5 mm diameter applied with a force of 3 N ± 10 percent. The end of the wire or rod shall be free from burrs and at right angles to its length.

The protection is satisfactory if the wire or rod cannot enter the enclosure.

C-7.3.2 *Protection Against Contacts with Live and Moving Parts*

The test is made with a straight rigid steel wire or rod of 2.5 mm diameter and 100 mm long with a force of

3 N ± 10 percent. The end of the wire or rod shall be hemispherically shaped.

The protection is satisfactory if adequate distance is maintained with live and moving parts inside the enclosure.

In addition, the sphere test for first numeral 2 is to be effected.

C-7.4 Test for First Numeral 4

C-7.4.1 *Protection Against Ingress of Solid Foreign Objects*

The test is made with a straight rigid steel wire of 1 mm diameter applied with a force of 1N ± 10 percent. The end of the wire shall be free from burrs and at right angles to its length.

The protection is satisfactory if the wire cannot enter the enclosure.

C-7.4.2 *Protection Against Contacts with Live and Moving Parts*

The test is made with a straight rigid steel wire or 1 mm diameter and 100 mm long with a force of 1N ± 10 percent. The end of the wire shall be hemispherically shaped.

The protection is satisfactory if adequate distance is maintained with live and moving parts inside the enclosure.

In addition the sphere test for first numeral 2 is to be effected.

C-8 TEST FOR SECOND CHARACTERISTIC NUMERAL

The test shall be conducted with fresh water.

For the condition of the equipment after the tests (*see* **C-8.5**).

C-8.1 Test for Second Numeral 1

The test is made by means of an apparatus the principle of which is shown in Fig. C3; the rate of discharge shall be reasonably uniform over the whole area of apparatus and shall produce a rainfall of between 3 mm and 5 mm of water per minute (In the case of an apparatus according to Fig. C2, this corresponds to a fall in water level of 3 mm to 5 mm per minute).

The equipment under test is placed in its normal operating position under the test apparatus, the base of which shall be larger than that of the equipment under test. Except for equipment designed for wall or ceiling mounting, the support for the equipment under test should be smaller than the base of the equipment.

Equipment normally fixed to a wall or ceiling is fixed in its normal position of use to a wooden board having dimensions which are equal to those of that surface of the equipment which is in contact with the wall or ceiling when the equipment is mounted as in normal use.

The duration of the test shall be 10 min.

C-8.2 Test for Second Numeral 2

The test apparatus is the same as that specified in **C-8.1** and is adjusted to give the same rate of discharge.

The equipment is tested for 2.5 min in each of four fixed positions of tilt. These positions are 15° either side of the vertical in two mutually perpendicular planes.

The total duration of the test shall be 10 min.

C-8.3 Test for Second Numeral 3

The test shall be made using test apparatus such as is shown in Fig. C3, provided that the dimensions and shape of the equipment to be tested are such that it will fit within the radius of the oscillating tube as shown. Where this condition cannot be fulfilled, a hand-held spray device, as shown in Fig. C4, shall be used.

a) Coniditions when using test apparatus as in Fig. C-3.

The water pressure is adjusted to give a delivery rate of at least 10 1/min.

Water pressure — 80 kN/m^2 (0.8 bar) approximately.

Method — The oscillating tube shall be provided with spray holes over an arc of 60° either side of the centre point and shall be fixed in a vertical position; the equipment tested is mounted on a turntable with a vertical axis and is located at approximately the centre point of the semi-circle. The turntable is rotating at a convenient speed so that all parts of the equipment are wetted during the test.

The minimum test duration shall be 10 min.

When it is not practicable to rotate the equipment on a turntable, it shall be placed at the centre of the semi-circle and the tube shall be oscillated through an angle of 60° either side of the vertical position at a rate of approximately 60°/s for 5 min. The equipment is then turned through a horizontal angle of 90° and the test continued for a further period of 5 min.

b) Conditions when using test apparatus as in Fig. C4.

The counter balanced shield shall be in place for this test.

The water pressure is adjusted to give a delivery rate of 10 l/min + 0.5 l/min (pressure approximately 80-100 kN/m^2 (0.8-1.0 bar).

The test duration shall be 1 min/mm^2 of calculated surface area of the enclosure (excluding any mounting surface) with a minimum duration of 5 min.

NOTE — For the purpose of this test, the surface area of the equipment is calculated with an accuracy of ± 10 percent.

C-8.4 Test for Second Numeral 4

The conditions for deciding whether the apparatus of Fig. C3 or that of Fig. C4 should be used are the same as those stated in **C-8.3**.

a) Using the apparatus of Fig. C3

The oscillating tube shall have holes drilled over the whole 180° of the semi-circle. The test duration, rate of oscillation and water pressure are as given in **C-8.3** (a).

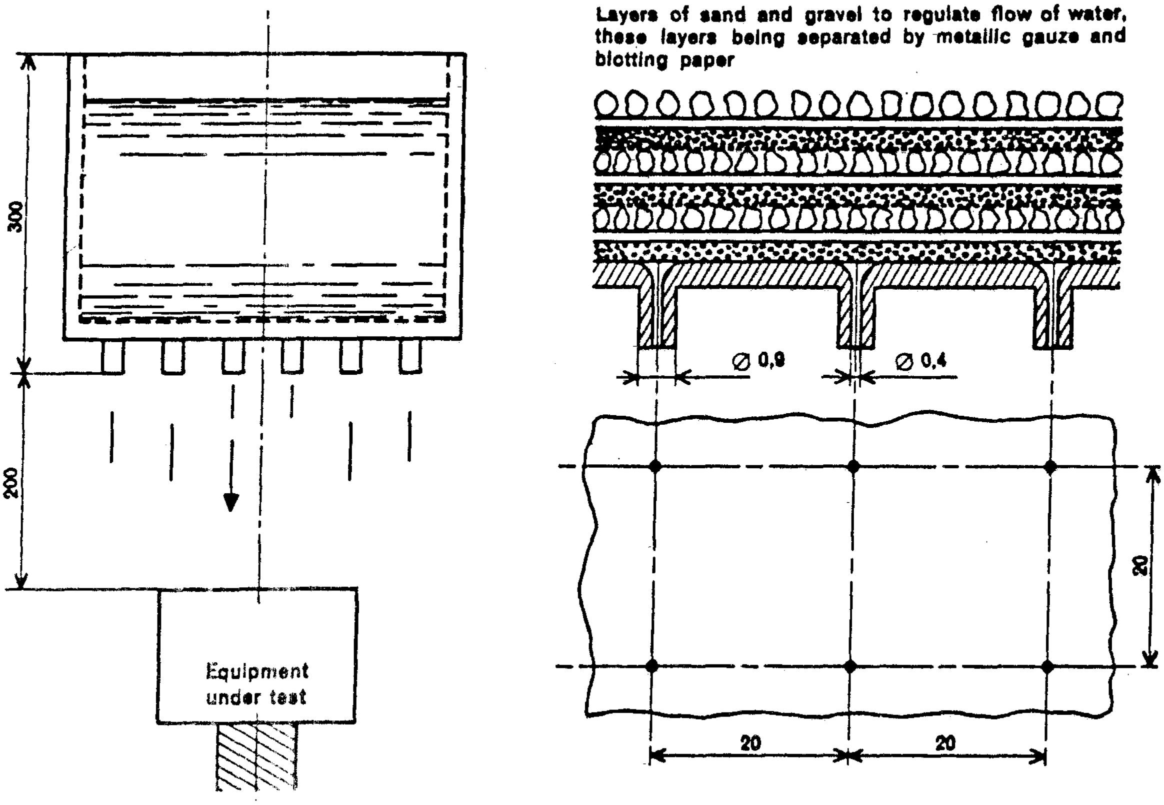

300
200
Equipment under test
Layers of sand and gravel to regulate flow of water, these layers being separated by metallic gauze and blotting paper
Ø 0,9
Ø 0,4
20
20
20

FIG. C2 APPARATUS FOR THE VERIFICATION OF PROTECTION AGAINST DRIPPING WATER

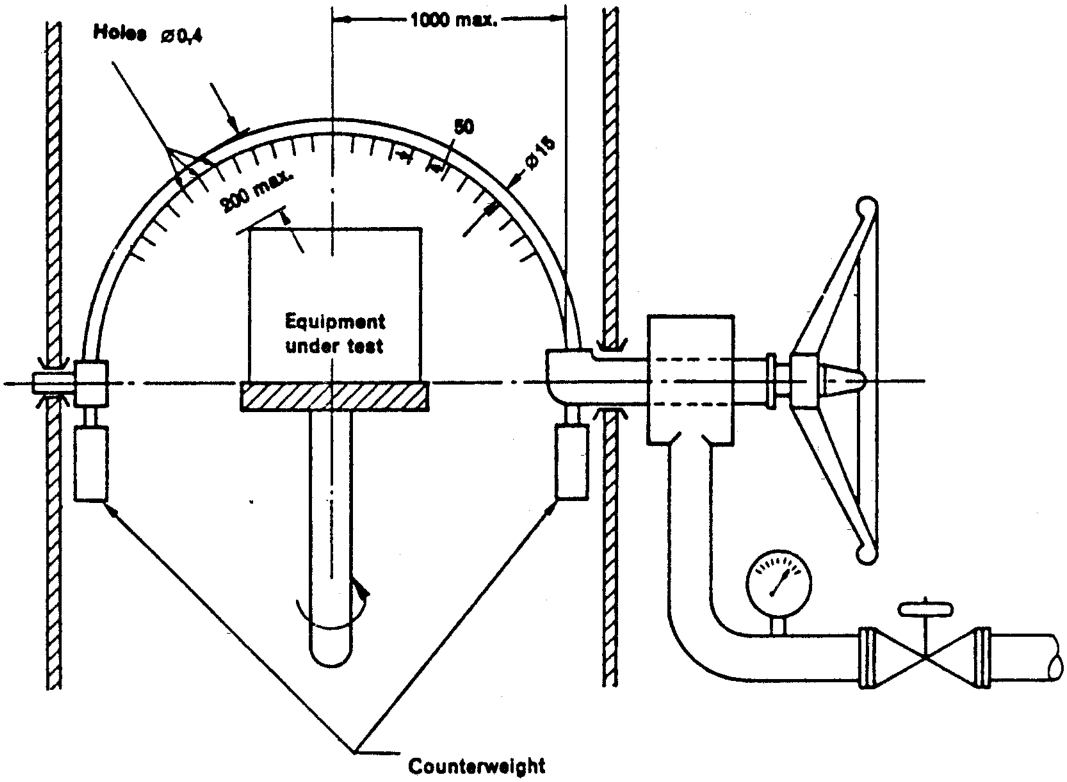
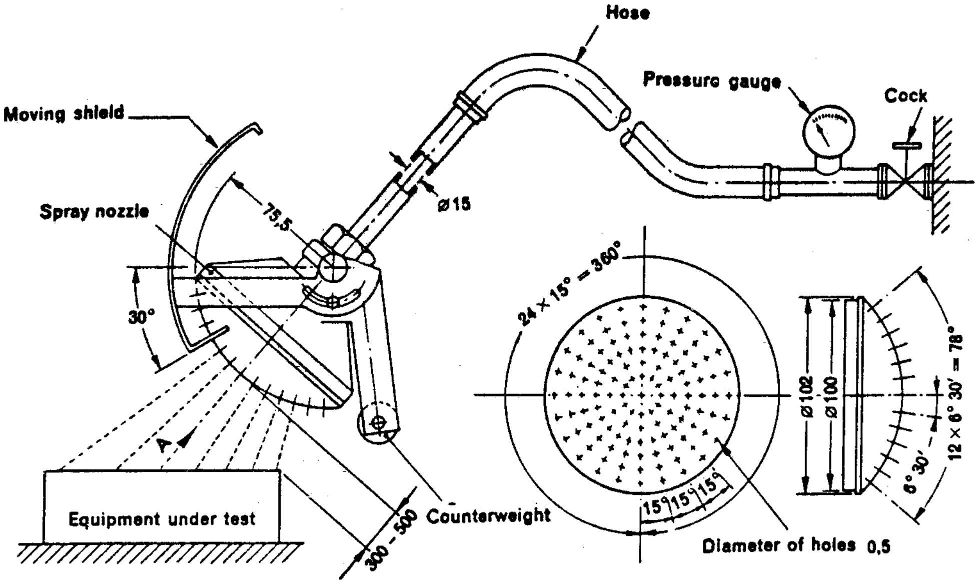


FIG. C3 APPARATUS FOR THE VERIFICATION OF PROTECTION AGAINST SPRAYING AND SPLASHING WATER



Viewed according to arrow A (with shield removed)

Dimensions in millimetres.

121 holes of ϕ 0.5:
1 hole at the centre
2 inner cricles of 12 holes at 30° pitch
4 outer circles of 24 holes at 15° pitch
Moving shield — Aluminium
Spray nozzle — Brass

FIG. C4 HAND-HELD APPARATUS FOR THE VERIFICATION OF PROTECTION AGAINST SPRAYING AND SPLASHING WATER

The support for the equipment under test shall be perforated so as to avoid acting as a baffle and the equipment shall be sprayed from every direction by oscillating the tube to the limit of its travel in each direction.

b) Using the apparatus of Fig. C4.

The counter balanced shield is removed from the spray nozzle and the equipment is sprayed from all practicable direction.

The rate of water delivery and the spraying time per unit area shall be as specified in **C-8.3**(b).

C-8.5 State of the Equipment after the Tests

After testing in accordance with the appropriate requirements of **C-8.1** to **C-8.4** the external surfaces should be dried, and then the equipment shall be inspected for ingress of water.

The evaluation of harmful ingress of water depends on the dimensions of the equipment, and it is not possible to establish a general method suitable for all types of enclosures.

For **C-8.1** to **C-8.4** if any water has entered, it shall not:

- be sufficient to interfere with satisfactory operation of the equipment;
- reach live parts or windings not designed to operate when wet; and
- accumulate near the conduit hole (cable entry) or enter the cable.

Where the water ingress could raise doubts as to the functioning of the equipment a dielectric test with reduced value shall be effected (for example, a minimum of 50 percent of the dielectric test voltage). If the equipment is provided with drain holes it shall be proved by inspection that any water which enters does not accumulate and that it drains away without doing any harm to the equipment.

ANNEX D

(*Clause* 2.0)

LIST OF REFERRED INDIAN STANDARDS

IS No.	*Title*
1885 (Part 17) : 1979	Electrotechnical vocabulary: Part 17 Switchgear and Controlgear (*First revision*)
2086 : 1993	Carriers and bases used in rewirable type electric fuses for voltages upto 650 V (*third revision*)
11353 : 1985	Guide for uniform system of making and identification of conductors and apparatus terminals
12063 : 1987	Classification of degrees of protection provided by enclosures of electrical equipment
13947	Low-voltage switchgear and controlgear:
(Part 1) : 1993	General rules
(Part 3) : 1993	Switches, disconnector, switch disconnectors and fuse-combination units

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Amendments Issued Since Publication

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